



US005936259A

United States Patent [19]

Katz et al.

[11] **Patent Number:** **5,936,259**[45] **Date of Patent:** **Aug. 10, 1999**[54] **THIN FILM TRANSISTOR AND ORGANIC SEMICONDUCTOR MATERIAL THEREOF**[75] Inventors: **Howard Edan Katz**, Summit, N.J.;
Joyce G. Laquindanum, Hatfield, Pa.[73] Assignee: **Lucent Technologies Inc.**, Murray Hill, N.J.[21] Appl. No.: **08/951,779**[22] Filed: **Oct. 16, 1997**[51] **Int. Cl.**⁶ **H01L 51/30**; H01L 51/40[52] **U.S. Cl.** **257/40**; 438/99; 438/151;
257/288[58] **Field of Search** 257/40, 288; 438/99,
438/151[56] **References Cited****U.S. PATENT DOCUMENTS**

5,574,291	11/1996	Dodabalapur et al.	247/40
5,596,208	1/1997	Dodabalapur et al.	257/66
5,612,228	3/1997	Shieh et al.	437/1
5,625,199	4/1997	Baumbach et al.	257/40
5,854,139	12/1998	Aratani et al.	438/780

OTHER PUBLICATIONSPatent No. HEI 8'1996'-18125, AA: "Novel π -Extended Thiphen-Fused Electron Acceptors for Organic Metals," by de la Cruz, P. et al., *J. Org. Chem.* 57, p. 6192."Logic Gates Made From Polymer Transistors and Their Use in Ring Oscillators", by Brown, A. R. et al., *Science*, vol. 270, pp. 972-974 (Nov. 10, 1995)."Semiconductor Devices", by Sze, S. M., *John Wiley & Sons*, pp. 200-207."Morphological Origin of High Mobility in Pentacene Thin-Film Transistors", by Laquindanum, J. et al., *Chemistry of Materials*, vol. 8, No. 11, pp. 2542-2544 (1996)."Organic Field-Effect Transistors with High Mobility Based on Copper Phthalocyanine", by Boa, Z. et al., *Appl. Phys. Lett.*, 69 (20), 11 pp. 3096-3068 (Nov. 11, 1996)."Soluble and Processable Regioregular Poly(3-hexylthipene) for Thin Film Field-Effect Transistotr Applications with High Mobility", by Bao, Z. et al., *Appl. Phys. Lett.*, 69 (26), p. 4108 (Dec. 23, 1996)."Structural Basis for High Carrier Mobility in Conjugated Oligomers", by Garnier, F. et al., *Workshop on the Materials Science of Conductive Polymers*, Vol. 45, p. 163 (1991)."Benzodithiophene Rings as Semiconductor Building Blocks", by Laquindanum, J. et al., *Advanced Materials*, 9, No. 1, pp. 36-39 (1997).*Primary Examiner*—John Guay*Attorney, Agent, or Firm*—Richard J. Botos[57] **ABSTRACT**

Thin film transistors in which the active layer is a film of an organic semiconductor with a structure having two or three six-membered, fused aromatic rings with two five-membered, heterocyclic aromatic rings fused thereto. The five-membered rings are either substituted or unsubstituted. If substituted, the substituents are either alkyl or alkoxyalkyl with about two to about 18 carbon atoms. The organic semiconductor compound has a field-effect mobility greater than 10^{-3} cm²/Vs and a conductivity less than about 10^{-6} S/cm at 20° C. Thin film devices made of these materials have an on/off ratio of at least about 100.

10 Claims, 1 Drawing Sheet